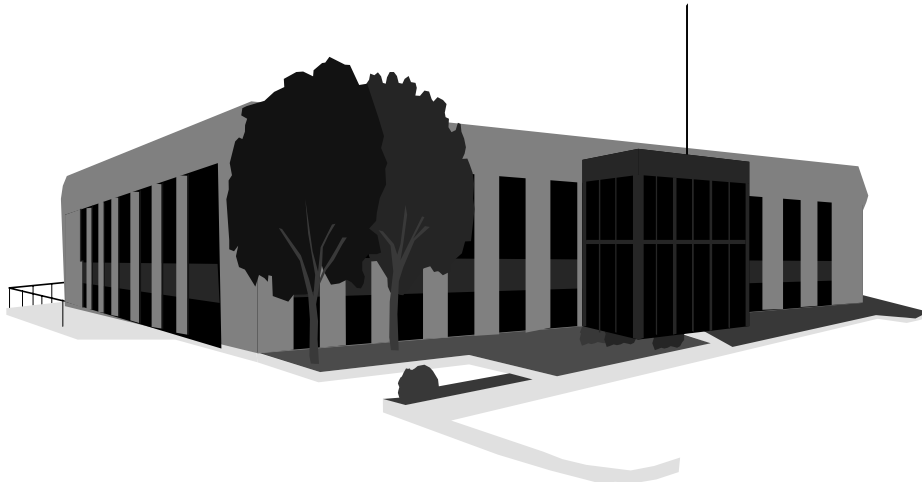


INDOOR AIR QUALITY ASSESSMENT

**Memorial Elementary School
2 Fiske Avenue
Upton, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
June, 2001

Background/Introduction

At the request of a parent, an indoor air quality assessment was done at the Memorial Elementary School in Upton, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA).

On May 2, 2001, a visit was made to this school by Cory Holmes, Environmental Analyst, ER/IAQ, BEHA to conduct an indoor air quality assessment. Mr. Holmes was accompanied by Ted Briggs, Upton Board of Health, Vincent Rozen, Principal, Memorial Elementary School, Kenny Choiniere, Director of Maintenance and Paul Diagle, Superintendent, Upton School District.

The school is a one-story brick building originally built in the early 1950's. An addition was completed in 1956. The building houses kindergarten through third grade students and is tentatively scheduled for demolition in 2003, following completion of construction of a new school on grounds adjacent to the Memorial School. The school consists of three classroom wings A, B & C; wings A & B are located in the original building and wing C is located in the 1956 addition (see Picture 1). The school is made up of general classrooms, library, computer room, art room, cafeteria/gymnasium and office space.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The school has a student population of approximately 170 and a staff of approximately 15. Tests were taken under normal operating conditions. Test results appear in Tables 1-3.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in four of twenty-six areas surveyed, indicating adequate fresh air ventilation in most areas of the school. It should be noted, however that the assessment was conducted on an unseasonably warm day and a number of areas had windows or exterior doors open during the assessment, which can greatly reduce carbon dioxide levels.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Pictures 2 & 3). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 4) and return air through an air intake located at the base of each unit ([see Figure 1](#)). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. The opening of fresh air dampers can be controlled manually by the use of a lever located on the side of each unit (see Picture 5). It should be noted that univents were installed during the original construction, which would make them approximately forty to fifty years old. All univents were operable and appeared to be well maintained. Most of the univents were deactivated during the assessment, but were reactivated by Mr. Choiniere so BEHA staff could observe operation.

Obstructions to airflow, such as items placed in front of univent returns, were seen in a few classrooms (see Picture 6). To function as designed, univents and univent returns must remain free of obstructions. Importantly, these units must be activated and allowed to operate during hours of school occupation.

Mechanical exhaust ventilation is provided by wall or ceiling-mounted intake grills connected to ductwork (see Pictures 7 & 8). A number of exhaust vents were not operating and were scheduled for repair by the Upton School Department's heating, ventilation and air conditioning (HVAC) consultant (Johnson Controls, Inc.). Exhaust vents in the original building have internal louvers that are controlled by pull chains to adjust airflow. A few of these vents were missing pull chains (see Picture 7). As with the univents, a number of exhaust vents were obstructed by tables, chairs, boxes and other items (see Picture 9).

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997, BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself at levels measured in this building.

It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this occurs a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

As mentioned previously, the assessment took place on a day of unseasonably warm weather (outside temperature ranged from 83 °F to 88 °F during the assessment). Temperature readings ranged from 78 °F to 84 °F, which were above BEHA's recommended comfort guidelines in most areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70 °F to 78 °F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. In addition, once repaired it would be expected that mechanical exhaust ventilation would serve to help circulate air and remove excess heat.

The relative humidity in the building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 18 to 30 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to

60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A few rooms had water-stained ceiling tiles, which are evidence of historic roof or plumbing leaks. Ceiling tiles are made of a non-porous material that is fixed directly to the ceiling by adhesive, rendering replacement difficult. No active roof leaks were reported to or observed by BEHA staff during the assessment. Upton School Department officials report that a preventative maintenance plan has been implemented to remediate occasional leaks in a timely manner.

Several classrooms had a number of plants, all of which appeared to be equipped with drip pans. Moistened plant soil and drip pans can serve as a source of mold growth. Over-watering of plants should be avoided and staff should ensure that plants are located away from univents to prevent the aerosolization of dirt, pollen or mold.

Other Concerns

Several other conditions were noted during the assessment, which can affect indoor air quality. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

The teacher's workroom contained a lamination machine. Lamination machines can give off heat and odors, particularly if the equipment is older and in frequent use. The lamination machine is stationed directly in front of the univent (see Picture 10), which can

serve to distribute heat and odors throughout the room. The room was subdivided into two areas separated by an approximate 7-8 foot partition. The mechanical exhaust vent for the original room is located in the adjacent room on the far wall. Without mechanical exhaust ventilation, pollutants produced by office equipment can build up and become a potential source of irritation to the eyes, nose and respiratory system.

Conclusions/Recommendations

In view of the findings at the time of our inspection, the following recommendations are made to improve general indoor air quality:

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. Adjust manual intake levers on univents to increase the percentage of fresh air intake if necessary.
2. Continue with plans to have rooftop exhaust motors repaired. Inspect exhaust flues for proper function; repair/replace pull chains as necessary.
3. Once the exhaust systems are operational, consider having the systems balanced by an HVAC engineering firm.
4. Remove all obstructions from univents and mechanical exhaust vents to facilitate airflow.
5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

6. Repair any existing water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
7. Ensure plants are located away from univents in classrooms. Ensure drip pans are placed underneath plants in classrooms. Examine drip pans periodically for microbial growth and disinfect with an appropriate antimicrobial where necessary.
8. Consider relocating lamination machine in teacher's workroom to an area equipped with local exhaust ventilation.

References

BOCA. , 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

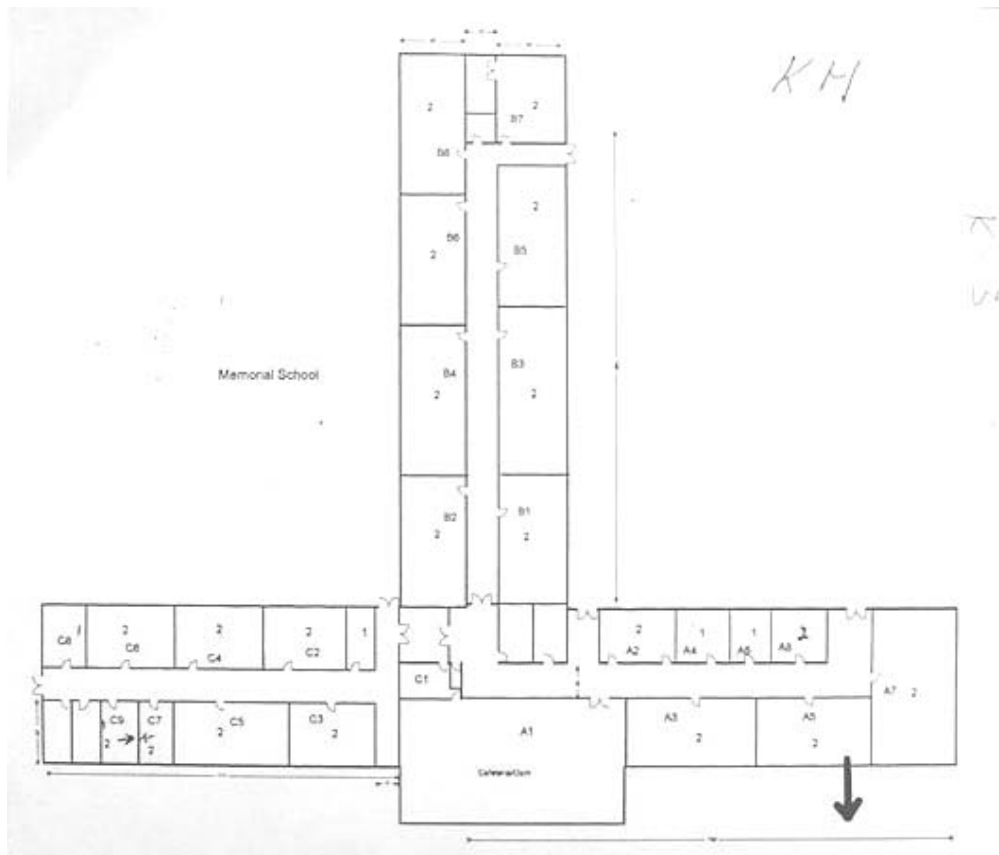
OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

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Picture 1



Floor Layout of Memorial Elementary School Upton, MA

Picture 2



Classroom Univent in Original Wing

Picture 3



Classroom Univent in 1956 Addition

Picture 4



Univent Fresh Air Intake on Exterior of Building

Picture 5



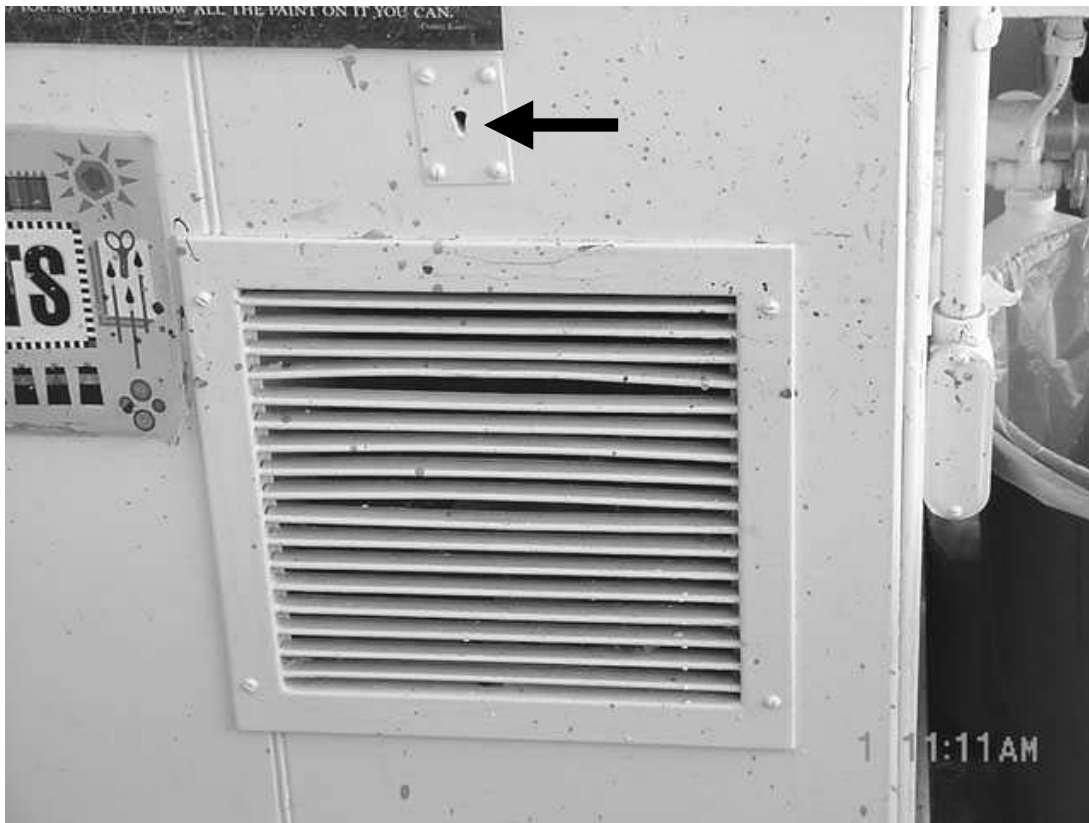
Manual Control to Adjust Fresh Air Dampers in Classroom Univents

Picture 6



Univent Return Vent (Front) Obstructed by Boxes and Other Items

Picture 7



Wall-Mounted Exhaust Vent Note Pull Chain Adjusting Interior Louver Missing

Picture 8



Ceiling-Mounted Exhaust Vent

Picture 9



Obstructed Wall-Mounted Exhaust Vent

Picture 10



Lamination Machine in Teacher's Workroom

TABLE 1

Indoor Air Test Results – Memorial Elementary School, Upton, MA – May 2, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	440	83	36					Weather conditions: clear, sunny, hot
B6	749	78	30	0	Yes	Yes	Yes	
B7	694	79	29	0	Yes	Yes	Yes	Door open
B8	682	79	30	0	Yes	Yes	Yes	
B5	685	79	30	0	Yes	Yes	Yes	
B3	851	82	30	22	Yes	Yes	Yes	Exhaust blocked, univent off-activated by school maintenance, exterior door open
B4	849	82	28	22	Yes	Yes	Yes	Exhaust blocked, univent off-items on top, exterior door open
B2	651	82	27	20	Yes	Yes	Yes	Univent off, exterior door open
B1	652	82	26	0	Yes	Yes	Yes	
Boy's Restroom					No	Yes	Yes	

* ppm = parts per million parts of air
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results – Memorial Elementary School, Upton, MA – May 2, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Girl's Restroom					Yes	Yes	Yes	
A3	579	83	26	0	Yes	Yes	Yes	Univent off, exterior door open
A5	639	83	27	0	Yes	Yes	Yes	Exhaust vent blocked, exterior door open
A7	741	82	26	18	Yes	Yes	Yes	Univent off-return blocked, exterior door open
A8	628	84	24	1	Yes	No	No	
A6	700	83	25	0	Yes	No	No	
Nurse's Office	580	83	24	0	Yes	No	No	
A2	540	83	24	1	Yes	No	No	Window open
Library	492	83	24	0	No	No	Yes	Local exhaust fan
C2	652	82	25	3	Yes	Yes	Yes	Univent and exhaust off, window open, water stained CT by maintenance station

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Temperature - 70 - 78 °F
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TABLE 3

Indoor Air Test Results – Memorial Elementary School, Upton, MA – May 2, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
C3	854	81	28	10	Yes	Yes	Yes	Exhaust off
OT/PT	689	81	27	3	Yes	Yes	Yes	Univent and exhaust off, 12 plants
C5	841	82	28	26	Yes	Yes	Yes	Univent off
(Temporary) Art Room	700	82	29	0	Yes	No	Yes	Sub divided room
C9	603	82	26	1	Yes	Yes	No	Univent off, laminating machine, teachers' lounge
C6	703	82	26	2	Yes	Yes	Yes	Univent off, window open
C-wing Restroom					No	Yes	Yes	
C8	635	81	26	3	Yes	No	No	
Cafeteria	738	82	18	~100	Yes	Yes	Yes	Ventilation systems off
Afternoon Background	438	88	32					

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